

LETTER TO THE EDITOR

EFFECT OF SIX WEEKS OF *SHAVASAN* TRAINING ON SPECTRAL MEASURES OF SHORT-TERM HEART RATE VARIABILITY IN YOUNG HEALTHY VOLUNTEERS

Sir,

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In an earlier work from our laboratory, we have demonstrated the effectiveness of *shavasan*, a yogic relaxation technique, in producing psychosomatic relaxation (1). The blood pressure (BP) lowering effect of *shavasan* has been demonstrated previously in subjects with hypertension (2). The cardiovascular effects of *shavasan* may at least in part be due to its effects on autonomic regulation of heart rate and blood pressure. Heart rate variability (HRV) analysis has come to be increasingly used in physiologic research studies as a noninvasive tool to examine the autonomic regulation of cardiovascular function. It describes the variability in instantaneous heart rates and assesses modulation of cardiac cycle time by intrinsic biological rhythms (3, 4, 5). Oscillations in instantaneous heart rates occur at high frequencies (0.15–0.40 Hz), low frequencies (0.04–0.15 Hz) and at very low frequencies (0.003–0.04 Hz) due to different physiologic mechanisms and these have been inferred from pharmacologic studies (3, 4, 5, 6). For a detailed discussion of the physiologic foundations of HRV, consult Akselrod (3, 4), Eckberg (5) and Pagani et al (6). Time-domain analysis is a simple method to quantify overall HRV whereas power spectral analysis provides a means of studying different mechanisms responsible for variability in instantaneous heart rates. Raghuraj et al have studied the effect of two yogic breathing techniques on heart rate

variability (7). The effect of *shavasan* training on HRV has not been studied so far. Hence, we planned to determine whether *shavasan* training of short duration has any effect on the low frequency and high frequency components of heart rate variability.

26 healthy subjects (13 boys and 13 girls) aged 16.1 ± 0.2 (mean \pm SD) years were recruited to the *shavasan* group and 17 age and gender matched healthy subjects (9 boys and 8 girls) aged 15.8 ± 0.6 years to the control group ($P=0.07$). The BMI of the *shavasan* and the control groups were 20.8 ± 2.8 kg/m² (mean \pm SD) and 19.3 ± 3.5 respectively ($P=0.16$). ECG (a bipolar chest lead) was continuously acquired at a rate of 1000 samples per second for five minutes using the BIOPAC[®] MP 100 hardware (BIOPAC Systems Inc., USA) and the AcqKnowledge[®] 3.7.1 software (BIOPAC Systems Inc., USA) and a Microsoft Windows-based PC. Blood pressure was measured by an automated non-invasive blood pressure monitor (Colins Press-Mate BP 8800, Colin[®] Corporation, Japan). Recordings were obtained in the Polygraph laboratory, between 10.00 am and 12.00 pm, 3 h after a light breakfast. The environment was quiet, the laboratory temperature 25°C, and the lighting subdued. After familiarizing the subject with the procedure and at least 10 minutes of rest in the supine position, ECG was recorded with subjects in the supine position. They were instructed to

breathe quietly at about 12 breaths per minute during the recording. None of the subjects were taking any medication influencing autonomic function. Under similar conditions, we determined the resting BP, heart rate (HR) and HRV, before and within 5 days after 6 weeks of *shavasan* training. *Shavasan* group was taught *shavasan* by a trained yoga teacher and subjects practised the same for 15 minutes a day, four days a week for a total duration of six weeks. The control group did not receive any *shavasan* training. The technique of *shavasan* is given elsewhere (8). The local ethics committee approved the study protocol. Written informed consent was taken from the parents of all subjects.

HRV analysis was done conforming to established standards (9) using the *AcqKnowledge 3.7.1* software. Briefly, ectopics and artifacts in the ECG were edited and a 256-second long RR interval tachogram obtained by using a rate-detection algorithm. The RR interval tachogram was resampled at 4 Hz, its mean and trend removed, a Hanning window applied and transformed by fast Fourier algorithm to obtain a power spectrum of RR intervals. Low frequency power (LF power) and high frequency power (HF power) were obtained by integrating the spectrum from 0.04–0.15 Hz and 0.15–0.40 Hz respectively (9). Total power was calculated as the sum of LF and HF powers (5).

The *shavasan* and control groups were compared by unpaired 't' test. After the training period, the spectral powers of the two groups did not follow a normal distribution and these were compared using a non-parametric test (Mann-Whitney test). Changes within the *shavasan* and control groups after the training period were analyzed by paired 't' test A P value less

than 0.05 was taken as indicating a statistically significant difference between the compared means.

Results are given in Table I. We could obtain HRV data only for 20 subjects in the *shavasan* group and 14 subjects in the control group. HRV could not be reliably determined from ECG with excessive noise, artifacts and these were not used for analysis. At baseline, the *shavasan* and the control groups were comparable in terms of their resting HR, systolic pressure (SP), diastolic pressure (DP), rate-pressure product (RPP), LF power, HF power and total RR spectral power ($P > 0.2$). Even after the six weeks training period, there were no significant differences between the *shavasan* and the control groups in terms of the above-mentioned parameters ($P > 0.05$).

In the *shavasan* group, we noted a significant decrease in resting HR following training ($P = 0.01$). As noted in Table I, there was a decrease in SP ($P = 0.05$), DP ($P = 0.03$) and RPP ($P = 0.012$) following *shavasan* training. In the control group, there was an insignificant decrease in resting HR ($P = 0.023$) and the mean SP and mean DP did not change in this group after the six-week period. An insignificant decrease in RPP was noted in this group ($P = 0.035$). In the *shavasan* as well as the control groups, changes in LF power, HF power, and total spectral powers after the six-week period were not significant ($P > 0.25$).

RR interval fluctuations occurring at respiratory frequencies are vagally mediated and have been shown to be nearly abolished by large-dose atropine (5). Baseline HF power expressed in absolute units of power quantifies vagally mediated fluctuations in instantaneous heart rates due to respiration. LF power expressed in absolute units of power quantifies RR interval

TABLE I: Resting heart rate, blood pressure and heart rate variability indices at baseline and at the end of the six-week training period in the *shivasan* and control groups. Data are expressed as mean \pm SD. HR: heart rate in beats per minute, SP: systolic pressure in mm Hg, DP: diastolic pressure in mm Hg, RPP: rate-pressure product in mm Hg \times beats per minute $\times 10^{-2}$, LF power: Low frequency spectral power of RR intervals in ms^2 , HF power: high frequency spectral power of RR intervals in ms^2 , total power: total spectral power of RR intervals in ms^2 .

	Baseline		After 6 weeks	
	Shivasan group	Control group	Shivasan group	Control group
HR	73 \pm 10	71 \pm 11	68 \pm 10***	68 \pm 11
SP	114 \pm 10	112 \pm 8	109 \pm 10*	112 \pm 9
DP	62 \pm 5	59 \pm 7	58 \pm 5**	59 \pm 5
RPP	84 \pm 15	79 \pm 14	75 \pm 10***	77 \pm 14
LF power	1518 \pm 1434	2148 \pm 1916	1635 \pm 1058	2376 \pm 1818
HF power	2742 \pm 2626	3090 \pm 2748	2751 \pm 1492	4742 \pm 5265
Total power	4260 \pm 3741	5238 \pm 4146	4385 \pm 2225	7119 \pm 6637

For HR, SP, DP and RPP, number of subjects in *shivasan* and control groups was 26 and 17 respectively. For LF power, HF power and total power, number of subjects in *shivasan* and control groups was 20 and 14 respectively. For all comparisons between *shivasan* and control groups at baseline and after six weeks, $P > 0.25$.

* $P=0.05$, ** $P=0.03$, *** $P=0.01$ with respect to baseline values.

fluctuations due to baroreflex-mediated changes in vagal nerve traffic to the heart (5). Total power quantifies heart rate variability due to LF and HF components. The ratio of low frequency to high frequency spectral powers has been used as an index of sympathovagal balance (5). However, in healthy subjects in the supine position, power in both the LF and HF ranges is nearly abolished by large dose atropine (5). Therefore, the assumption that LF/HF ratio signifies sympathovagal balance, especially in the supine position, is problematic (5). This is why we have only analyzed changes in absolute powers of the LF and HF components of HRV. We have not attempted to analyze overall HRV or quantitate sympathovagal balance.

In this study, we have noted large variations in spectral measures of HRV in both the groups, at baseline as well as immediately after the study period. This could possibly be due to interindividual variations in cardiac responsiveness to

changes in vagal nerve traffic to the heart. Singh et al have demonstrated that a substantial proportion of the variance in HRV noted in a population is due to genetic factors (10). Goldberger et al have postulated that HRV initially increases with increasing vagal nerve traffic to the heart and then decreases with further increase in vagal tone (11). The absence of a significant change in LF and HF powers in our subjects may have been due to the fact that their baseline HRV was saturatingly high. Secondly, the intensity of training may not have been adequate to produce a quantifiable change in HRV.

In conclusion, the present study shows that *shivasan* training for 15 minutes a day, 4 days a week, for six weeks does not significantly affect heart rate variability in young healthy subjects. Further studies may be undertaken to determine the effect of longer duration of *shivasan* training on heart rate variability. This study demonstrates a useful method of examining

the effects of yogic techniques on autonomic modulation of cardiovascular function. Since the BP and HR lowering effects of *shavasana* have been previously demonstrated in subjects with hypertension, it follows that the effects of *shavasana* and other relaxation techniques may be more apparent in subjects with reduced baseline HRV. Controlled studies done on subjects with reduced baseline HRV may provide us with more useful information of clinical significance.

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REFERENCES

- Madanmohan, Rai UC, Balvittal V, Thombre DP, Swami Gitananda. Cardiorespiratory changes during savitri pranayam and shavasana. *The Yoga Review* 1983; 3: 25–34.
- Datey KK, Deshmukh SN, Dalvi CP, Vinekar SL. *Shavasana*: A yogic exercise in the management of hypertension. *Angiology* 1969; 20: 325–333.
- Akselrod S, Gordon D, Ubel FA, Shannon DC, Barger AC, Shannon DC, et al. Power spectrum analysis of heart rate fluctuation: a quantitative probe of beat-to-beat cardiovascular control. *Science* 1981; 213: 220–222.
- Akselrod S. Components of heart rate variability: basic studies. In: Malik M, Camm AJ, (eds). *Heart Rate Variability*. Armonk, New York, *Futura* 1995; 147–163.
- Eckberg DL. Sympathovagal balance: a critical appraisal. *Circulation* 1997; 96: 3224–3232.
- Pagani M, Lombardi F, Guzzetti S. Power spectral analysis of heart rate and arterial pressure variabilities as a marker of sympatho-vagal interaction in man and interaction in man and conscious dog. *Circ Res* 1986; 59: 178–193.
- Raghuraj P, Ramakrishnan AG, Nagendra HR, Telles S. Effect of two selected yogic breathing techniques on heart rate variability. *Indian J Physiol Pharmacol* 1998; 42: 467–472.
- Swami Gitananda. *Shavasana*, the corpse posture. In: *Yoga: Step-by-Step*, Pondicherry, Satya Press. 1981: A–4.
- Heart rate variability: Standards of measurement, physiological interpretation and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. *Circulation* 1996; 93: 1043–1065.
- Singh J, Larson M, O'Donnell C. Heritability of heart rate variability: the Framingham Heart Study. *Circulation* 1999; 99: 2251–2254.
- Goldberger JJ, Challapalli S, Tung R, Parker MA, Kadish AH. Relationship of heart rate variability to parasympathetic effect. *Circulation* 2001; 103: 1977–1983.